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OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

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SUBJECT: Tier 1 Drinking Water Estimated Environmental Concentrations for Urea.

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This memorandum transmits the Tier I estimated drinking water concentrations for urea use on citrus. The FQPA Index Reservoir Screening Tool (FIRST)[1] was used to estimate these concentrations. The GENERIC Estimated Environmental Concentration (GENEEC 2.0)[2] was also used to estimate the surface water concentrations for urea to establish risk to aquatic organisms when used as an inert ingredient.

The SCI-GROW[3] model was used to estimate groundwater drinking water concentrations for urea. Modeling results are shown in Table 1.

Table 1. Estimated environmental concentrations (ppm) of urea in surface and groundwater.

Scenario	peak	long term average	use(s) modeled	PCA
Surface water (FIRST)	4.85	0.01	6 application @ 80 lb/acre on citrus	0.87
Surface water (GENEEC)	3.58	0.04	6 application @ 80 lb/acre	
Groundwater	0.001		6 application @ 80 lb/acre	

Environmental Fate and Transport Assessment

EFED has no fate data for Urea. Available data from literature reviews shows that urea degrades rapidly in most soils[4-6]. In general, urea is rapidly hydrolyzed to ammonium through soil urease activity. In various soils, the hydrolysis may near completion within 24 hrs[4]; however, the rate of hydrolysis can be much slower depending upon soil type, moisture content, and urea formulation. For example, increasing the pellet size of urea fertilitizers can decrease the urea decomposition rate from days to weeks. Soil adsorption studies have demonstrated that urea adsorbs very weakly to soil[7]; therefore, leaching is possible. Ultimate urea degradation produces ammonia and CO_2 as volatile products[8].

Biodegradation is expected to be the major fate process in the aquatic ecosystem. Various screening studies have demonstrated that urea can biodegrade readily[9-13] with the release of CO_2 and ammonia. The rate of biodegradation generally decreases with decreasing temperatures[12]; under cold winter-like conditions, biodegradation may be relatively slow (0-6% per day)[12]. The presence of naturally-occurring phytoplankton increases the degradation rate[10,13] because phytoplankton use urea as a nitrogen source[10] and because urea is decomposed by phytoplankton photosynthesis[13]; in phytoplankton-rich waters, degradation occurs much faster in sunlight than in the dark[13].

Abiotic hydrolysis of urea occurs very slowly in relation to biotic hydrolysis[14]. Abiotic hydrolysis yields ammonium carbamate which decomposes to form CO_2 and ammonia[14]; the enzyme urease catalyzes urea hydrolysis.

In one photodegradation study using a silica gel adsorbent[9] only 0.2% of applied urea photomineralized after a 17-hr irradiation with a UV lamp (>290 nm).

The adsorption of urea was measured in six different British soils with organic carbon contents ranging from 1.76 to 36.5%; no adsorption was measurable in five of the soils[15]; in the sixth soil (36.5% organic carbon), a K_{OC} of 8 can be determined from the measured Freundlich isotherm[16].

Surface Water

Monitoring

At the present time, the EFED has no monitoring data on the concentrations of urea in surface water.

Modeling

Surface water concentration estimates were modeled for the use of urea on citrus using FIRST and GENEEC Tier I models. The input parameters used in simulations are shown in Tables 2 and 3.

Table 2. Input parameters for Tier I model FIRSt used for Urea.

Parameter	calculations/value	source
Crop name	citrus	EPA Reg. Lable No. 688915.
application rate (lb ai/acre)	81	EPA Reg. Lable No. 688915.
interval between applic. (day)	10	EPA Reg. Lable No. 688915.
Max No. application	6	EPA Reg. Lable No. 688915.
PCA factor (decimal)	0.87 (default)	Effland et al[17] (2000).
Koc (mL/g)	8	Hance (1965).
soil aerobic met. $t_{1/2}$ (d)	1 X 3	Scheunert I. (1987); FIRST User Manual.
pesticide to be wetted-in ?	No	EPA Reg. Lable No. 688915
method of application	aerial	EPA Reg. Lable No. 688915.
solubility (mg/L)	5.45×10^5	Yalkowsky S.H. (1989)[18].
aerobic aquatic met. $t_{1/2}$ (d)	0.042 (assumed to be 1 hour: readily degraded)	Freitag D. (1985).
hydrolysis (pH 7) $t_{1/2}$ (d)	1	Sankhayan et al. (1976).
aqueous photolysis $t_{1/2}$ (d)	stable (0.2% < degraded after 17 hours of radiation)	Freitag et al. (1985).

Table 3. Input parameters for GENEEC 2.0 modeling of urea.

Parameter	calculations/value	source
Crop name	citrus	EPA Reg. Lable No. 688915.
application rate (lb ai/acre)	81	EPA Reg. Lable No. 688915.
interval between applic. (day)	10	EPA Reg. Lable No. 688915.
Max No. application	6	EPA Reg. Lable No. 688915.
Koc (mL/g)	8	Hance (1965).
soil aerobic met. $t_{1/2}$ (d)	1 X 3	Scheunert I. (1987); FIRST User Manual.
pesticide to be wetted-in ?	No	EPA Reg. Lable No. 688915
method of application	aerial	EPA Reg. Lable No. 688915.
Aerial droplet size distribution	fine to medium (default)	GENEEC Users Manual.
solubility (mg/L)	5.45×10^5	Yalkowsky (1989).
aerobic aquatic met. $t_{1/2}$ (d)	0.042 (assumed to be 1 hour: readily degraded)	Freitag (1985).

hydrolysis (pH 7) $t_{1/2}$ (d)	1	Sankhayan and Shukla (1976).
aqueous photolysis $t_{1/2}$ (d)	stable (0.2% < degraded after 17 hours of radiation)	Freitag (1985).

Groundwater

Monitoring

EFED has no monitoring data on the concentrations of urea in groundwater.

Modeling

The SCI-GROW model was used to estimate potential groundwater concentrations. SCI-GROW is a screening model for ground water. It is based on a regression approach which relates the concentrations found in ground water in Prospective Ground Water studies to aerobic soil metabolism rate and soil-water partitioning properties of the chemical.

The input and output files used in SCI-GROW are shown in Appendix I.

References

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6. Scheunert I. 1987. Chemosphere 16: 1031-1041.

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11. Scheunert I. 1987. Chemosphere 16: 1031-41.

12. Evans W.H. 1973. Water Res 7: 975-985.

13. Mitamura O., and Y. Saijo. 1980. Marine Biology 58: 147-152.

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15. Hance R.J. 1965. Weed Res 5: 98-107.

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APPENDIX I

FIRST output file

```
 RUN No.   1 FOR urea ON citrus       * INPUT VALUES *

------------------------------------------------------------------
RATE (#/AC) No.APPS &   SOIL  SOLUBIL  APPL TYPE  %CROPPED INCORP
ONE(MULT)    INTERVAL    Koc   (PPM )   (%DRIFT)     AREA    (IN)

------------------------------------------------------------------
81.000( 89.921)   6  10   8.0*******   AERIAL(16.0)  87.0    .0


   FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)

------------------------------------------------------------------
METABOLIC  DAYS UNTIL  HYDROLYSIS  PHOTOLYSIS   METABOLIC
COMBINED
FIELD)  RAIN/RUNOFF  (RESERVOIR)  (RES.-EFF)   (RESER.)  (RESER.)

------------------------------------------------------------------
3.00        2          N/A     30.00- 3720.00      .04       .04


UNTREATED WATER CONC (MILLIGRAMS/LITER (PPM))    Ver 1.0 AUG 1,
2001

------------------------------------------------------------------
    PEAK DAY  (ACUTE)      ANNUAL AVERAGE (CHRONIC)
      CONCENTRATION             CONCENTRATION

-----------------------------------------------------------------
          4.848                                   .010
```

GENEEC 2.0 input and output files

```
RUN No.    1 FOR UREA   ON    CITRUS          * INPUT VALUES *
--------------------------------------------------------------------
RATE (#/AC)    No.APPS &  SOIL  SOLUBIL   APPL TYPE NO-SPRAY INCORP
ONE(MULT)     INTERVAL   Koc   (PPM )     (%DRIFT)   (FT)     (IN)
--------------------------------------------------------------------
81.000(108.000) 10    6  8.0   *******   AERL_B( 13.0)     .0    .0

   FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)
--------------------------------------------------------------------
METABOLIC   DAYS  UNTIL   HYDROLYSIS    PHOTOLYSIS    METABOLIC
COMBINED
  (FIELD)   RAIN/RUNOFF   (POND)      (POND-EFF)     (POND)
(POND)
--------------------------------------------------------------------
3.00        2           N/A     30.00- 3720.00      .04        .04

GENERIC EECs (IN MILLIGRAMS/LITER (PPM))  Version 2.0 Aug 1, 2001
--------------------------------------------------------------------
PEAK      MAX 4 DAY     MAX 21 DAY    MAX 60 DAY    MAX 90 DAY
GEEC      AVG GEEC       AVG GEEC      AVG GEEC      AVG GEEC
--------------------------------------------------------------------
3.58       .90            .17              .06           .04
```

SCI-GROW input and output

```
   RUN No.   1 FOR UREA                 INPUT VALUES
--------------------------------------------------------------
APPL (#/AC)  APPL.  URATE    SOIL    SOIL  AEROBIC
RATE          NO. (#/AC/YR)  KOC   METABOLISM (DAYS)
----------------------------------------------------------------
81.000        10   810.000   8.0        1.0


   GROUND-WATER SCREENING CONCENTRATIONS IN PPB
----------------------------------------------------------------
                    1.376344
----------------------------------------------------------------
  A=       .167  B=    13.000  C=     -.778  D=     1.114  RILP=
 -.867
  F=    -2.770  G=       .002  URATE=   810.000  GWSC=
1.376344
```